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PROSPECTIVE EVALUATION OF PUMPKIN SEED OIL AS AN ALTERNATIVE FUEL – A NOVEL EXPERIMENTATION

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ABSTRACT

There is a major issue worldwide on the level of contamination caused by emissions of I. C. Engines that debilitate the issues concerning the high cost of raw petroleum. This has prompted an alternative for diesel engine. The pursuit has been centered on vegetable oil due to its sustainable source from agribusiness and the way that it is richly accessible and uniformly circulated everywhere throughout the world. One of such vegetable oil sources is "Fluted Pumpkin plant" ("Telfairia Occidentalis Hook F.") which is from the cucurbit case family and is described by its thick and enlarged fruit size. It is a creeper vegetative shrub that spreads low over the ground and has expansive lobed leaves and tendrils. Generally, the oil from pumpkin seeds can be extracted in a mechanical extractor utilizing "normal hexane" as solvent and transesterified to get bio fuel whose fuel properties can be assessed following the American Society for Testing and Materials (ASTM) techniques for biodiesel. The biodiesel thus obtained can likewise be utilized in different blends with the petroleum diesel in Four stroke naturally aspirated Diesel Engines. Phytosterols present in the pumpkin seed oil are likewise being considered for their part in bringing down cholesterol levels. The pumpkin seeds (oil and cake) can be profitable as additives in a variety of applications, since they give a decent wellspring of protein, and are rich in antioxidants, which can help prevent cancer; they are high in "monounsaturated and polyunsaturated fatty acids". At the point when pumpkin seed oil is expelled from the seed, a by-product in the form of "pumpkin seed cake" is produced. Pumpkin seeds basically comprise of protein and fat giving a concentrated source of energy. The current work involves extraction of biofuel from pumpkin seeds and blending it with the diesel at different constituent percentage of 10, 20, 30 and 40, followed by evaluation of the characteristics. The results clearly infer that the blending of the bio diesel with the petroleum diesel will vary the properties such as Flash Point, Fire Point, Viscosity and Calorific Value which may have further effect on the performance characteristics of "Internal combustion engines".

***KEYWORDS:** Pumpkin Seed Oil, Alternative, Bio-Fuel, Blend, Trans-Esterification, Performance & Analysis*

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INTRODUCTION

Fossil fuel is used as a major energy source across the world, the rampant usage of fossil fuels will lead to depletion of the resources in coming future. As the petroleum derivatives are on the verge of depletion, there is a need to discover an alternative fuel to satisfy the energy needs of the world. Today with the ascent in costs of petroleum based fuels and the pollution levels, it is becoming increasingly difficult for human population across the

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globe. Henceforth, an alternate source of fuel in the form of Biofuel is outstanding amongst other accessible sources to satisfy the energy request of the world. Biofuel is the man's best seek after alleviation from the deficiencies of fossil fuels. Because of expanding condition mindfulness, Biofuels are picking up acknowledgment across the globe as a sustainable fuel, which will soon become a contrasting option to diesel fuel with no adjustments to the Engine. Biofuels can be synthesized from "ethanol and vegetable oil and animal fats". Use of Bio-fuels result in favorable circumstances: they are sustainable, more secure, bio-degradable, do not contain sulphur and they decrease engine emissions. Presently the cost of this fuel is an essential factor that confines its utilization. Thus, it current work, detailed research on alternative fuels blended with pumpkin seed oil known for its low carbon emissions and economy is carried out to evaluate the prospects of the bio-fuels from pumpkin seed as an alternative fuel.

LITERATURE SURVEY

A Literature Survey has been carried out to effectively find out the gap and formulate a base for selection of the process methodology. A review of some of the literature referred has been presented.

A vast work has been carried out for the production of biodiesel from fluted pumpkin seed oil by E me Bello, et al., They have reported that the fluted pumpkin seed oil extracted can be converted to biofuels by trans-esterification process and further utilized by blending with diesel for various constituent percentages. The biofuel produced exhibit high flash point and low pour point [1].

The study carried out by Anh N P et. al., presents trans-esterification of pumpkin oil to produce biodiesel. A maximum biodiesel (96.32%) was observed under optimum conditions for pumpkin oil trans-esterification (Temperature - 50oC, molar ratio of methanol to oil - 6:1, KOH - 1.2 Vol. % and Time Duration of Trans-esterification - 90 minutes). Performance characteristics of B20 were found to be quite high as compared to petroleum diesel. Thus 20% blend of pumpkin oil biodiesel can be safely used with petroleum diesel [2].

Dunn R O et. al., have extensively worked on synthesis of Biodiesel from oils extracted out of vegetable and fruit seeds, Methanolysis of muskmelon seed oil was optimized employing RSM (response surface methodology). Four process variables were evaluated at two levels: methanol/oil molar ratio, catalyst concentration in relation to oil mass. Multiple regression analysis was employed to get the quadratic polynomial equation for predicting trans-esterification using RSM. The result indicated that catalyst concentration and reaction temperature were the important factors that significantly affect the yield of biodiesel [3].

Van Gerpen et al., have carried out experimental work on “7 B. H. P Single cylinder four stroke vertical, water cooled Diesel engine” at rated speed of 1500 rpm, Different blends of transesterified mahua oil with diesel were tested at 200 bar injection pressure. From the performance characteristics of transesterified mahua oil diesel blends, the efficiencies obtained were found to be better with 75% transesterified mahua oil [4].

“Experimental study on a diesel engine using mahua oil as fuel” was carried out by Kumar et al., and the properties of mauha oil were determined. The performance and emission of a single cylinder stationary diesel engine was evaluated using mahua oil and compared with standard diesel operation. Mahua oil was preheated to 130oC and the effect of preheating on the engine performance and emission were determined [5].

"Evaluation of Biodiesel Fuel" by Fukuda et al., describes some of the principal characteristics of biodiesel and usage experience in and near the State of Montana. The emissions-related impacts of biodiesel on several pollutants were

quantified, along with potential effects of these impacts on the state and vehicle users within the state [6].

Pryde et al., have carried out extensive work on Bio – Diesel performance analysis in an air cooled direct internal combustion engine, the experiment was carried out in triplicate to determine the production conditions with optimum yield. The produced Biodiesel had fuel properties which satisfied both ASTME D6751 and EN 1424 standards. The fatty acid profile of the Biodiesel revealed the dominant fatty acids were linoleic (64.50%), oleic (17.54%) and palmitic (12.70%). Exhaust emissions from an internal combustion (I. C.) engine revealed that the CO and NOx emissions reduction were 60% and 58% at B20 respectively. Meanwhile, the HC emission reduction was found to be 60% at B20, Smoke opacity emission reduction was found to 64% at B20, BSFC was found to be 42% emission reduction at B20. However, the flue gas temperature and BTE increased by 12% and 45%, respectively [7].

Turck et al., have carried out a “feasibility study of Melon Seed Oil as a source of bio diesel”, The Oil was extracted from musk melon seeds at a high return of 52.2%. The extracted oil was subjected to oil quality tests and thus trans-esterified to give "fatty acid methyl esters or biodiesel". The biodiesel was likewise subjected to fuel quality tests. The outcomes demonstrated that the "Extracted Oil" had "Specific gravity of 0.91" and "moisture content of 0.90 %" showing that the oil is a distinct energy source, a great possibility for trans-esterification and won't be "susceptible to microbial attack" and auto-oxidation. The fuel quality parameters of the synthesized biodiesel demonstrated that it complies with the standards for biodiesel and contrasts well with a standard petro-diesel [8].

MATERIALS AND METHODS

Pumpkin Seed Oil is extracted from the dried pumpkin seeds using mechanical extractor and then trans-esterified to get the bio-diesel which is characterized for its basic properties. The materials and methods used for synthesis of bio diesel from pumpkin seed oil and subsequent evaluation of the fuel properties are distinctly explained in this section.

Extraction of Oil from Pumpkin Seeds

The pumpkin seeds are procured from UAS, GKVK Extension Centre, Bangalore. The seeds are “air-dried, weighed, ground and extracted in a Mechanical extractor using hexane as the solvent”. The extracted oil is eventually evaluated for basic fuel properties.

Synthesis of Bio – Diesel

The biodiesel is synthesized from pumpkin seed oil by following the procedures afore mentioned, Reference has been taken for synthesis of biodiesel from works of Kennedy IzuchukwuOgunwa, “4.0 g of Potassium hydroxide is added to 50 ml of methanol solution taken in a 100 ml conical flask. The mixture in the conical flask is then stirred and simultaneously heated to a temperature of 60o C. The Sodium Hydroxide/Methanol mixture (also known as Methoxide) is then added to 250 ml of pumpkin seed oil in 1000 ml conical flask and stirred thoroughly for several hours. The entire mixture is then transferred to a “separating funnel” and allowed to settle for duration of 12 Hours to give two distinct layers of lower glycerol and upper methyl esters (biodiesel). Transfer the biodiesel into the reaction vessel having a double walled condenser fitted with a reaction vessel and recovery flask. The biodiesel is heated and the temperature is maintained at 70oC, at this temperature, methanol starts evaporating which is then condensed and the “condensate methanol” is collected in recovery flask. The separated bio diesel is then transferred into the washing funnel, 300 ml of water at a temperature of 70oC is poured into the washing funnel, which is allowed to settle for 15 minutes; After the above mentioned procedures, a bottom layer of soap water is formed which is then drained carefully, this cycle of procedures is repeated until p H of soap

water reaches a magnitude of 7. The biodiesel thus obtained is then dried by heating to a temperature of 100oC in a 1 litre beaker to remove the traces of moisture content".

Characterization of Bio – Diesel

The biodiesel is then characterized for flash point and fire point using Cleveland Pensky apparatus; kinematic viscosity and dynamic viscosity using Cannon Fenske and Redwood Viscometer setup; calorific values from Bomb Calorimeter. The results are then compared with that of the values of Petroleum Diesel, The characteristics of the bio diesel is validated and analysed for variation in the blend composition ranging from 10 vol. % to 40 vol. %.

RESULTS AND DISCUSSIONS

The results obtained after each of the characteristic tests is tabulated and the observations are inferred. The findings for each of the properties of the biodiesel synthesized from pumpkin seed oil is presented in this section.

Flash Point

"The flash point of a flammable liquid is the lowest temperature at which it can form an ignitable mixture with the air, at this temperature the vapor may cease to burn when the source of ignition is removed". The flash point of the pure diesel is determined to be 49oC, while the flash point increases with the addition of Biodiesel into the diesel fuel and is found to be maximum for B40 blend (300 ml Diesel and 200 ml Biodiesel).

Table 1: Flash Point Temperature of Various Blends

BLENDS	Flash Point (^{o} C)
B10 (450ml Diesel and 50ml Biodiesel)	50
B20 (400ml Diesel and 100ml Biodiesel)	51
B30 (350ml Diesel and 150ml Biodiesel)	53
B40 (300ml Diesel and 200ml Biodiesel)	56
Pure diesel	49

The graph as shown in Fig – 1 gives the variation of the flash point with the increase in the blend composition of the biodiesel in the diesel, it also gives the Pearson's r value (Coefficient of Correlation) and Coefficient of Determination (COD) R Square value for linear curve fitting which can help predict Fire point for the other blends as well.

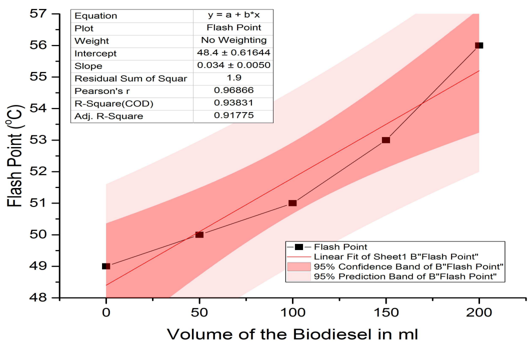

Figure 1: Flash Point for Different Blends of the Bio Diesel

Fire Point

The fire point of a fuel is the temperature at which it will continue to burn after ignition for at least 5 seconds. At the flash point, a lower temperature, a substance will ignite, but vapour might not be produced at a rate sustain the fire.

Table 2: Fire Point Temperature of Various Blends

BLENDS	Fire Point (°C)
B10 (450ml Diesel and 50ml Biodiesel)	53
B20 (400ml Diesel and 100ml Biodiesel)	54
B30 (350ml Diesel and 150ml Biodiesel)	57
B40 (300ml Diesel and 200ml Biodiesel)	63
Pure diesel	53

The fire point of the pure diesel is determined to be 53oC, while the Fire Point increases with the addition of Biodiesel into a diesel fuel and is found to be maximum for B40 blend (300 ml Diesel and 200 ml Biodiesel).

The graph as shown in fig below gives the variation of the flash point with the increase in blend composition of the bio diesel in the diesel; it also gives the Pearson's r value (Coefficient of Correlation) and Coefficient of Determination (COD) R Square value for linear curve fitting which can help predict Fire point for other blends as well.

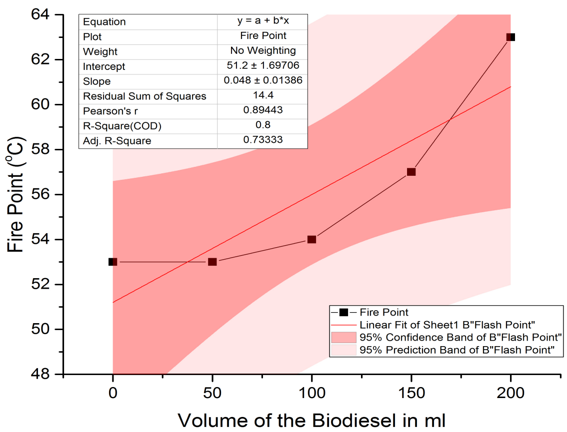

Figure 2: Fire Point for Different Blends of the Bio Diesel

Viscosity

Viscosity is the property of a fluid that tends to prevent it flowing when subjected to an applied force. High viscosity fluid resists flow, low viscosity fluids flow easily. The tenacity with which a moving layer drags adjacent layer of fluid along with it determines its viscosity, which is measured in a viscometer, a container with a standard sized orifice in the bottom. The rate at which fluid flows through the orifice is the measure of its viscosity.

Table 3: Viscosity for Different Blends of the Bio Diesel

BLENDS	Density (ρ) Kg/m^3	Dynamic Viscosity(μ) Pa-sec	Kinematic Viscosity(ν) m^2/sec
B10 (450ml Diesel and 50ml Biodiesel)	840	$1.21*10^{-3}$	$1.44*10^{-6}$
B20 (400ml Diesel and 100ml Biodiesel)	840	$2.47*10^{-3}$	$2.94*10^{-6}$
B30 (350ml Diesel and 150ml Biodiesel)	840	$3.9*10^{-3}$	$4.65*10^{-6}$
B40 (300ml Diesel and 200ml Biodiesel)	840	$6.47*10^{-3}$	$7.710*10^{-6}$
Pure diesel	832	$3.35*10^{-3}$	$4.09*10^{-6}$

The viscosity of the blends increases with the increase in blend composition from 0 Vol. % to 40 Vol. %, the viscosity of B30 blend is close to that of the viscosity of diesel.

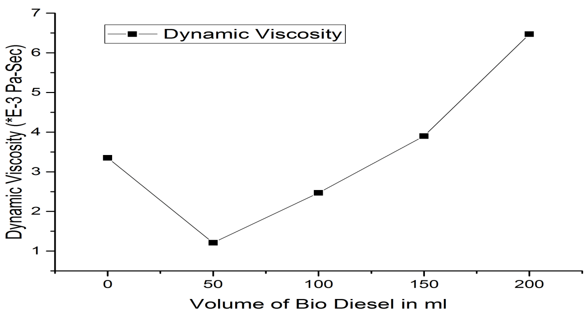

Figure 3: Dynamic Viscosity for Different Blends of the Bio Diesel

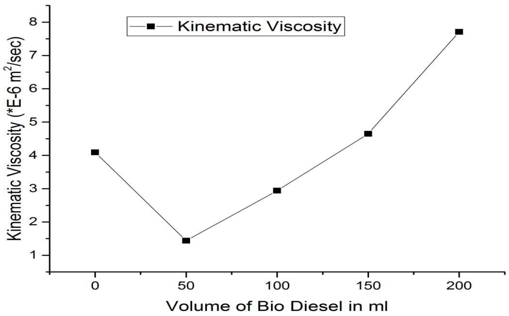

Figure 4: Kinematic Viscosity for Different Blends of the Bio Diesel

Calorific Value

"Calorific value is used to define the amount of heat released during the combustion of a fuel or food. It is measured in units of energy per amount of material depending on the context; heating value may be reported as Btu/m3, Kcal/kg, KJ/kg, J/mol or a variety of other combinations of units."

"The Apparatus used to find the calorific value is Bomb Calorimeter".

Table 4: Calorific Value for Different Blends of Bio – Diesel

BLENDS	Calorific value (CV) KJ/kg
B10 (450ml Diesel and 50ml Biodiesel)	43680
B20 (400ml Diesel and 100ml Biodiesel)	41546
B30 (350ml Diesel and 150ml Biodiesel)	35470
B40 (300ml Diesel and 200ml Biodiesel)	29442
Pure diesel	45000

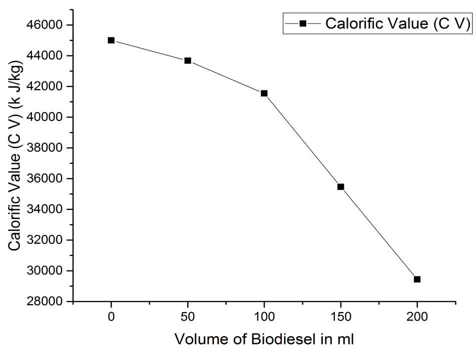

Figure 5: Calorific Value for Different Blends of Biodiesel

CONCLUSIONS

- It is found that there is an increase in flash point and fire point with an increase in blend percentage.
- It is found that there is a decrease in Calorific value for Biodiesel when compared with diesel. An approximation method is used to calculate the Calorific value of blend percentage.
- The density of the blinds increased with increase in percentage of the blend.
- It is also observed that there is an increase in viscosity with an increase in blend percentage.
- Critical analysis has clearly given inferences that when pumpkin oil is converted into biofuel by trans-esterification. The properties of the Biodiesel synthesized match to a maximum extent with that of the Petroleum Diesel.

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